ECRONICON OPEN ACCESS

EC NUTRITION
Research Article

A Study on the Effect of Blanching and Different Sugar Solution on the Quality of Candy Prepared from Bottle Gourd by Osmotic Dehydration Technique

Tania Sultana[1], Sultana Anjuman Ara Khanom[2], M Kamruzzaman[3] and Laisa Ahmed Lisa[4]*

[1]*Department of Microbiology, Jagannath University, Dhaka, Bangladesh*

[2]*Vegetable Technology Research Section, Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh*

[3]*Department of Applied Nutrition and Food Technology, Islamic University, Kushtia, Bangladesh*

[4]*Department of Biochemistry and Molecular Biology, Jagannath University, Dhaka, Bangladesh*

***Corresponding Author**: Laisa Ahmed Lisa, Department of Biochemistry and Molecular Biology, Jagannath University, Dhaka, Bangladesh.

Received: August 14, 2020; **Published:** August 31, 2020

Abstract

The aim of the research was to develop candy from bottle gourd using different sugar solutions and to study the effects of blanching and sugar solution on the characteristic of candy. Candy was prepared from both blanched and unblanched Bottle gourd by immersing into 50%, 55% and 60% sugar solution for 24 hours. Moisture, ash, protein, fat, total sugar, carbohydrate and microbiological status of the prepared candy were analyzed. There was a tendency of decreasing Ash, Protein, Fat, Total sugar, Carbohydrate and Energy (Kcal) content, whereas an increasing trend of moisture content was observed during the 4 months preservation period for both blanched and unblanched candy and all 3 types of sugar concentration. Total coliform and yeast and mold count were found nil during the 4 months of preservation period and this was true for candy made form blanched as well as unblanched Bottle gourd. Moreover, candy made with 60% sugar solution form blanched bottle gourd shown lower standard plate count than the candy prepared with 50% sugar solution. However, the difference was negligible. The best characteristic of bottle gourd candy was found with 50% sugar solution and prepared from blanched bottle gourd.

Keywords: *Bottle Gourd Candy; Sugar Solution; Nutritional Composition; Sensory Score; Microbial Load*

Introduction

Bottle gourd (*Lagenaria siceraria*) is a vegetable of Cucurbitaceae family grown typically on tropical and sub-tropical regions of the earth. Bottle gourd is generally grown in winter season and is a good source of carotene, calcium and vitamin C. In Bangladesh around 10,000 ha of land is cultivated to produce about 62,000 mt of Bottle Gourd. This vegetable is ready to harvest within 55 - 60 days, yield ranges from 35 - 40 mt/ha. The varieties of bottle gourd include BARI Lau-1, Khetlau and Hazari [1]. Bottle gourd is principally used in making curry with different fishes. In addition, its leaves and vines are also used as vegetables. Sometimes sweet desert is also prepared from bottle gourd with sugar and milk.

Bottle gourd is one of the excellent fruit or vegetable contain almost all of the essential nutrients required for normal growth, development and good human health. Almost every household, particularly in rural area, cultivate this vegetable as part of subsistence

agriculture. This home gardening practice help ensure food security and food diversity for the household. Bottle gourd can withstand at minimum 10°C and maximum 40°C, but prefers the climate which is dry and neither very cold nor very hot. Winter season of Bangladesh is favorable for its successful production [2].

Being easy to digest bottle gourd have a cooling effect on human body and rich sources of Vitamin B and ascorbic [3]. Few studies suggested that bottle gourd may help reduce urinary tract infection, heart problems, insomnia and diabetes. Moreover, studies also suggested its effect in maintaining cholesterol level and blood pressure. Being alkaline in nature, bottle gourd help reduces acidity and help in condition of stomach disorders and constipation, indigestion, diarrhea and piles. Rich in fiber, bottle gourd also help to reduce hunger keeping one full for the longest period of time. With almost 96% of water and ow calories (12 kcal/100g), bottle gourd is considered as one of the important weight reducing vegetables [4].

Malnutrition is a great problem in Bangladesh and most of the children are suffering from nutritional problem. Children are usually fond of sweets and we can prevent the nutritional problem through the bottle gourd candy and other foods processed from bottle gourd. Preparation of candies from fruits and vegetables are becoming popular because it reduces the volume and increases the shelf life retaining the nutritional value. Planners and policy makers have yanked light on the processing of fruit and vegetable to minimize the postharvest losses and to contribute to the economic development of rural population.

The scarcity of appropriate preservation methods is an important issue in Bangladesh, which may contribute to the decreased consumption of fruits and vegetables. Osmotic dehydration with mechanical drying is a process of preservation which has potential to give a higher quality product. Using osmotic dehydration technique, water is removed by placing fruits and vegetables into concentrated sugar solutions. The dehydration occurs principally due to water flow from low concentrated fruits and vegetables to the concentrated sugar solutions, which is an effect of osmotic pressure. Osmotic dehydration is a simple procedure to accomplish at ambient temperature and the color, texture and nutrients are not lost during the process. Moreover, literature study support that blanching as an important step of processing vegetables and vegetable products that help to preserve color, flavor and texture and extend shelf life of final products [5,6].

Aim of the Study

The aim of this study was to develop a bottle gourd candy using osmotic dehydration and mechanical drying procedure and to study the effect of blanching on the final products.

Materials and Methods

Materials

The current study was conducted in the period from February 2016 - August 2016, at the Vegetable Technology Section, Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh. Raw bottle gourd and sugar were used for making bottle gourd candy and were collected from local markets of Dhaka. The sample was filled in polythene bag and kept at room temperature in sealed box at laboratory until use.

Methods

After collection fresh bottle gourds were washed under running water to remove dirt and to reduce the number of viable microorganisms. After washing, bottle gourd was spread on blotting paper and gentle air blow was used to remove from the surface water. The bottle gourds were then skinned and cut into small cubes (1 cm × 1 cm) and were used immediately for the experimentation. The samples were boiled in addition with 2% salt and 0.05% SMBS (sodium meta bi sulfate) in stainless steel saucepan for 5 - 10 minutes to minimize the undesirable changes in color and texture. Pieces of bottle gourd cubes are then boiled with different concentration (50%, 55%, 60%) of

sugar solution with 0.25% citric acid for 10 - 15 min. The boiled bottle gourd was then set to cool and retained in ambient temperature for about 24 hours to let osmotic dehydration drain out free water attached to gourds and then dehydrated at 60˚-70˚C in mechanical dryer for 6 - 7 hours to avail moisture content ≤ 10%. Prepared bottle gourd candy were then enclosed in polythene pouch and conserved in a calm place in a sealed plastic box for storage.

Proximate nutritional analysis

The samples was dried at 105^0C in a dehydrating oven until a constant weight was reached to measure moisture content [7]. A muffle furnace was used to heat the sample at 600^0C for 4 - 6 hours to determine the ash content [8]. Micro-Kjeldahl method of AOAC was used to determine the protein content [9]. By this method first the percent nitrogen content was determined and then the factor 6.25 was used to determine the % crude protein content. Soxhlet apparatus was used to determine the total lipid content of sample [10]. Acid-Alkali Hydrolysis as described by AOAC was used to analyze the Crude fiber content [11]. The sum of the values of moisture, ash, protein, fat and crude fiber was subtracted from 100 (per 100 gm) to calculate the available carbohydrate content [12]. Osmotic dehydration methods was used to measure the amount of weight loss [13]. According to Nieto., *et al.* [14] solid gain and water loss were determined. The energy content of the raw material and final product was determined from the amount of protein, fat, and carbohydrate using the following equation [15]:

Energy = (Protein × 4.1) + (Fat × 9.3) + (Carbohydrate × 4.1)

Microbiological analysis of bottle gourd candy

Microbiological analysis of the bottle gourd candy was carried out to measure total bacterial, Coliform and Fungal load. Standard plate count (SPC), total fungus and record of Coliform of the food sample was inspected. After sterilization of all the media and equipment, 10 gm of each sample was aseptically taken, and 10 times thinned with sterilized distilled water and mixed well. Decimal dilution technique was followed to measure standard plate count and for fungus and yeast count pour plate method and spread plate method was followed. In the pour plate method, liquid sterilized agar medium (after cooling to about 45^0C) was transferred on a sterilized petri plate containing 1ml of sample. After mixing the sample and media was then allowed to solidify and incubated at 37^oC temperature for 24 - 72 hours [16,17]. Yeast and Mold counts were measured using spread plate method. In this method around 15 ml of decontaminated medium was dispensed in a sterilized Petri dish and was kept at ambient temperature until solidified. Then 0.2 ml sample was taken onto the solidified medium and then the sample was dispersed on agar plate [18,19]. All of the experiment was done in triplicate.

Most Probable Number (MPN) method was used for isolation and enumeration of total coliform. In this method serially diluted sample was inoculated into broth media from the gas positive (fermentation of lactose) tubes and the number of organisms was estimated from the statistical tables [20-22].

Sensory evaluation of bottle gourd candy

The taste testing of bottle gourd candy sample was carried out at the Quality Control section of institute of food science and technology (IFST) of Bangladesh council for scientific and industrial research (BCSIR), Dhaka. This taste testing was conducted by 7 panelists and each panelist gives a score to the bottle gourd candy for color, texture, flavor, softness, taste and overall acceptability for acceptance or rejection of the food. A 9-point Hedonic scale explained by Larmond was used in the evaluation of bottle gourd candy, where the lowest point represent extremely dislike and the highest point 9 as extremely like [23,24].

Results

Weight reduction and solute gain of bottle gourd

Figure 1 reveals that the higher the concentration of sugar solution the rapid the reduction of weight/dehydration. This rapid rate was observed for both blanched and unblanched bottle gourd. Compared to blanched bottle gourd, unblanched reached around 50% weight

reduction whereas this percentages were around 45% for blanched bottle gourd. During the 4 hours dehydration technique, 47.38, 49.62 and 52.50% of weight was reduced for 50, 55 and 60% sugar solution for unblanched bottle gourd. Whereas the amount of weight reduction was 39.11%, 45.62% for blanched bottle gourd.

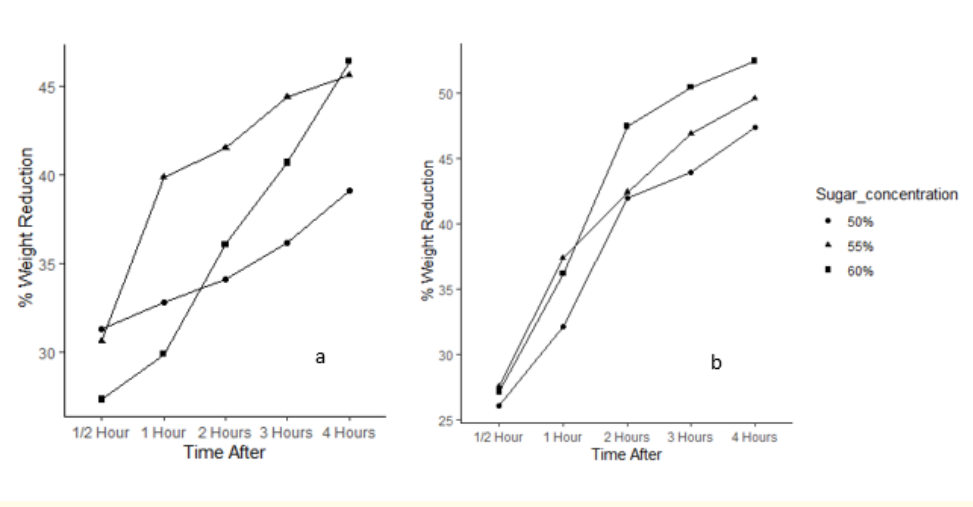

Figure 1: *Weight reduction of blanched (a) and unblanched (b) Bottle gourd candy during preparation.*

From figure 2, it has also revealed that the percentages of solute gain is proportional to the sugar concentration and the same effect is true for both blanched and unblanched bottle gourd. After half an hour solute gain of blanched bottle gourd was 2.61% for 50% sugar solution, 4.06% for 55% sugar solution and 4.34% for 60% sugar solution. At 4hrs solute gain was 7.27%, 8.01%, 10.76% for 50%, 55% and 60% sugar solution. After 1/2-hour solute gain of unblanched bottle gourd was 1.85%, 2.05% and 2.36% for 50%, 55%, 60% sugar solution whereas at 4hrs 5.45%, 6.86%, 9.29% for 50%, 55% and 60% sugar solution. Unblanched Bottle gourd shown more solute gain (>10%) compared to blanched Bottle gourd (> 9%) (Figure 2).

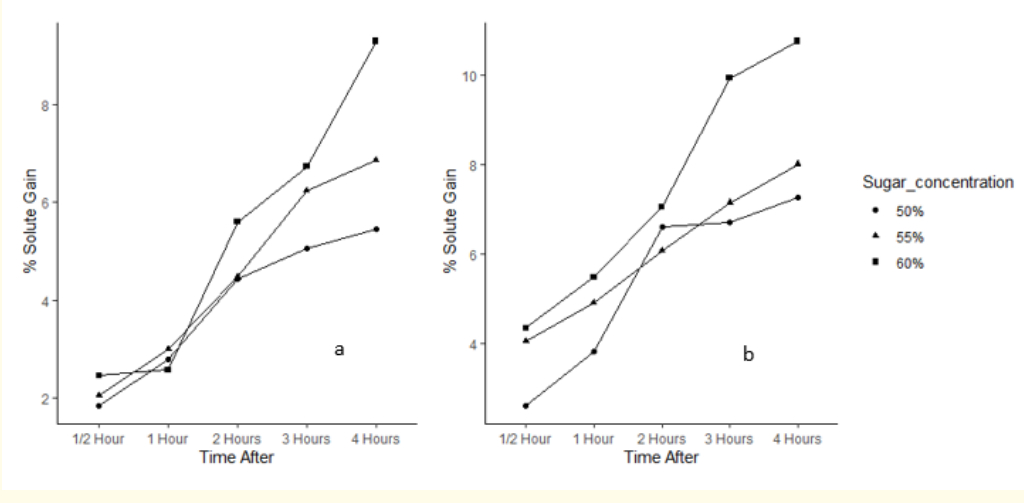

Figure 2: *Solute gain of blanched (a) and unblanched (b) Bottle gourd candy during preparation.*

Effect of blanching and sugar concentration on nutritional composition of bottle gourd candy

For 50% sugar solution, it has been shown that (Table 1) ash, protein, fat, sugar, crude fiber and energy was decreased with increasing moisture content for both blanched and unblanched candy. When it was freshly prepared, the moisture content was 6.36% for blanched bottle gourd candy and 5.90% un-blanched gourd candy. After 1months the moisture content was increased to 6.98% for blanched bottle gourd candy and 6.31% for unblanched gourd candy, whereas decreased nutrient content was observed for both. After 4month of storage the moisture content was soared to 8.78% for blanched bottle gourd candy and to 8.43% for unblanched bottle gourd, while, nutrient content was moderately decreased when compared to the 1st month. For 55% sugar concentration, it was also shown that the steady reduction of ash, protein, fat, sugar, crude fiber and energy, with the increase of moisture content of these candy (Table 1). When it was freshly prepared the moisture, content was 4.51% for blanched bottle gourd candy and 7.33% un-blanched gourd candy. After 1months the moisture content was soared to 5.10% for blanched bottle gourd candy and 7.64% for unblanched bottle gourd candy and nutrient content was decreased for both. After 4month the moisture content was soared to 7.1% for blanched bottle gourd candy and 8.5% for unblanched bottle gourd and nutrient content was moderately reduced compare to the 1st month.

	Raw Bottle gourd	Candy with 50% sugar solution					Candy with 55% sugar solution					Candy with 60% sugar solution				
		Time at or after (Month/Months)					Time at or after (Month/Months)					Time at or after (Month/Months)				
Parameter		**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
		Blanched														
Moisture (%)	95	6.36	6.98	7.32	8.40	8.78	4.51	5.10	6.10	6.52	7.75	4.31	6.79	7.32	7.5	7.65
Ash (%)	0.27	0.57	0.46	0.40	0.33	0.32	0.43	0.36	0.32	0.29	0.25	0.57	0.46	0.45	0.40	0.39
Protein (%)	0.87	1.25	1.09	1.02	0.94	0.925	2.82	1.35	1.22	1.09	1.02	1.37	1.35	1.30	1.20	0.98
Fat (%)	0.014	0.099	0.0707	0.055	0.002	0.001	0.098	0.06	0.04	0.002	0.001	0.099	0.06	0.03	0.0302	0.01
Total sugar (%)	3.15	52.04	45.10	42.86	40.31	38.36	55.50	49.25	37.34	35.23	33.50	71.50	65.91	58.65	46.42	44.21
Carbohy-drate (%)	3.85	91.72	91.40	91.21	90.33	89.97	94.14	93.13	92.32	92.10	90.98	93.65	91.34	90.9	90.86	90.97
Energy (Kcal)	19.47	382.101	379.84	378.63	374.21	372.69	398.45	387.92	383.88	382.08	377.20	390.50	389.38	378.29	377.76	377.08
		Un-blanched														
Moisture (%)		5.90	6.31	7.90	8.28	8.63	5.65	6.23	7.8	8.2	8.58	5.24	6.19	7.32	7.23	8.56
Ash (%)		0.98	0.82	0.83	0.79	0.75	0.49	0.46	0.41	0.38	0.35	0.65	0.63	0.57	0.49	0.46
Protein (%)		1.14	1.04	1.02	0.88	0.83	1.26	0.97	0.93	0.92	0.88	1.71	1.29	1.15	1.02	0.96
Fat (%)		0.089	0.065	0.045	0.003	0.002	0.067	0.060	0.03	0.0202	0.0105	0.087	0.07	0.05	0.003	0.001
Total sugar (%)		51.193	44.44	39.59	36.64	33.48	70.24	57.26	50.92	48.25	45.80	72.57	66.50	62.40	51.16	48.32
Carbohy-drate (%)		91.09	91.03	90.20	89.99	89.80	92.53	92.28	90.83	90.47	90.17	92.31	91.82	90.91	91.25	90.01
Energy (Kcal)		388.97	383.53	374.44	372.59	371.63	385.16	382.88	376.49	374.88	373.44	386.30	382.40	377.91	378.36	376.62

Table 1: *Nutritional composition of raw bottle gourd and candy prepared from blanched and unblanched bottle gourd with different concentration of sugar solution.*

Similarly, for 60% sugar solution, it was also found that that the steady decrease of ash, protein, fat, sugar, crude fiber, and energy, with the increase of moisture content of these candy. When it was freshly prepared the moisture, content was 6.3% for blanched bottle gourd candy and 5.24% un-blanched gourd candy. After 1months the moisture content was increased to 6.79% for blanched bottle gourd candy and 6.59% for unblanched gourd candy and nutrient content was decreased for both. After 4month the moisture content was increased to 7.65% for blanched bottle gourd candy and 8.56% for unblanched bottle gourd and nutrient content was relatively decreased compare to 1st month. At the early month preservation, the moisture content of candy, prepared with 50% sugar solution, was 6.36%. Whereas, these percentages 4.51 to 4.31 sugar concentration 55% and 60% respectively. After 4 months of preservation the moisture content of candy prepared from 50, 55 and 60% sugar solution were 8.78, 7.75 and 7.65% respectively. At the initial month the moisture content of candy prepared from unblanched bottle gourd with 50% sugar solution was 5.90 and it was reduced subsequently to 5.65 to 5.24% with increasing the sugar concentration from 55 to 60%. Whereas, at the final month, candy prepared from blanched bottle gourd the moisture content of candy with 50% sugar solution was 8.63and it was decreased accordingly 8.58 to 8.56 with increasing the sugar concentration from 55% to 60%.

At the beginning month of preservation, the total sugar content of blanched bottle gourd candy was 52.04, 55.50 and 71.50% for 50, 55 and 60% sugar solution respectively for candy prepared from blanched bottle gourd. After 4 months of preservation, the total sugar content of candy was 38.36, 33.50 and 44.21% respectively for 50, 55 and 60% sugar solution used. Whereas, for candy prepared from with unblanched bottle gourd, 51.193, 70.24 and 72.57% total sugar content was observed at the early month of preservation with respect to 50, 55 and 60% sugar solution used. Whilst, at the final month the total sugar content of candy prepared from unblanched bottle gourd with 50, 55 and 60% sugar solution were 33.48, 45.80 and 48.32% respectively.

A proportional relationship between sugar solution used and fat content of candy was observed. At the early month the total fat content of candy (blanched bottle gourd) with 50% sugar solution was 0.09 and 0.089 for unblanched bottle gourd candy. From the table 1 it was also found that at the final month the total fat content of blanched bottle gourd candy with 50% sugar solution was 0.001 and 0.002 for unblanched bottle gourd candy. If sugar concentration is increased, then ash content is decreased and, on the opposite, if the sugar concentration is decreased then ash

content increased. The ash content of product was 0.57 (for 50% sugar solution), 0.43 (for 55% sugar solution) and 0.57 for 60% sugar concentration and for 55% and 60% it was 0.43 and 0.57. From the table 1 it was also found that at the final month the total ash content of bottle gourd with 50% sugar solution was 0.32 (for blanched) and 0.73 (for unblanched) and for 55% and 60% it was 0.35 and 0.46. At the initial month the total protein content of blanched bottle gourd candy was 1.25, 2.82, 1.37% with 50%, 55% and 60% sugar solution and protein content of un-blanched bottle gourd candy was 1.14, 1.26 and1.71%. After 1 month the protein content was decreased to 1.09, 1.35, 1.37% for blanched bottle gourd candy at 50%, 55%, 60% sugar concentration and for unblanched gourd candy protein content was also decreased to 1.04, 0.97 and 1.29% for 50%, 55%, 60% sugar concentration. After 4 months the protein content was decreased to 7.1% for blanched bottle gourd candy and 8.5% for unblanched bottle gourd and nutrient content was relatively reduced compare to 1st month.

Effect of sugar concentration on sensory qualities of candy

A panel of judge assess the color, flavor, texture and overall acceptability of candies made from blanched and unblanched bottle gourd. From the table 2, highest value of organoleptic test for color is obtained 8 (out of 9) in bottle gourd candy with 50% sugar solution and the lowest score of 7.85 was obtained for candy prepared with 60% sugar solution, whereas the score was 8 for candy with 55% sugar solution. Average score for color of bottle gourd candy indicating that candy with 50% sugar solution is more acceptable than 55% and 60%. From the table 2 highest value of organoleptic test for flavor is obtained 8.28 (out of 9) in candy with 50% sugar solution and the lowest 8 obtained in candy with 60% sugar solution where 8.14 obtained in candy with 55% sugar solution. Average score for flavor of bottle gourd candy indicating that candy with 50% sugar solution is more acceptable than 55% and 60%.

Sensory Characters	Type of Sugar Solution	Score							
		Judge 1	Judge 2	Judge 3	Judge 4	Judge 5	Judge 6	Judge 7	Averages
Color	50%	8	8	8	7	9	8	9	8.14
	55%	7	9	8	9	8	8	7	8
	60%	8	8	7	7	8	8	9	7.85
Flavor	50%	8	8	9	8	7	9	9	8.28
	55%	8	7	8	8	9	9	8	8.14
	60%	9	8	7	8	8	8	8	8
Softness	50%	9	9	8	9	9	9	8	8.71
	55%	8	8	9	8	7	8	8	8
	60%	8	8	9	8	7	7	8	7.85
Taste	50%	9	8	7	8	8	8	8	8
	55%	8	8	7	8	9	7	7	7.71
	60%	8	8	7	8	9	7	6	7.57
Texture	50%	9	8	8	9	9	7	7	8.428
	55%	9	8	7	8	9	7	8	87
	60%	8	8	7	8	6	7	8	7.42
Overall acceptance	50%	8	8	9	8	8	8	8	8.14
	55%	7	9	9	8	7	8	8	8
	60%	7	8	8	8	8	8	8	7.85

Table 2: *Sensory evaluation of bottle gourd candy prepared from blanched and un-blanched candy.*

From the table 2 highest value of organoleptic test for flavor is obtained 8.71 (out of 9) in candy with 50% sugar solution and the lowest 7.85 obtained in candy with 60% sugar solution where 8 obtained in candy with 55% sugar solution. Average score for softness of bottle gourd candy indicating that candy with 50% sugar solution is more acceptable than 55% and 60%. Highest value of organoleptic test for taste is obtained 8 (out of 9) in bottle gourd candy with 50% sugar solution and the lowest 7.57 obtained in candy with 60% sugar solution of bottle gourd candy where 7.71 obtained in candy with 55% sugar solution (Table 2). Average score for taste of bottle gourd candy indicating that candy with 50% sugar solution was more acceptable than 55% and 60%. Highest value of organoleptic test for texture is obtained 8.42 (out of 9) in bottle gourd candy with 50% sugar solution and the lowest 7.42 obtained in candy with 60% sugar solution of bottle gourd candy where 8 obtained in candy with 55% sugar solution (Table 2). Average score for texture of bottle gourd candy indicating that candy with 50% sugar solution is more acceptable than 55% and 60%. Moreover, highest value of organoleptic test for overall acceptance is obtained 8.14 (out of 9) in bottle gourd candy with 50% sugar solution and the lowest 7.85 obtained in candy with 60% sugar solution of bottle gourd candy where 8 obtained in candy with 55% sugar solution (Table 2). Average score for overall acceptance of bottle gourd candy indicating that candy with 50% sugar solution is more acceptable than 55% and 60.

Effect of blanching and sugar solution on microbial load of bottle gourd candy

The total viable bacterial counts of sample are shown in table 3. It was observed from that at the early month the bacterial load on candy prepared from blanched bottle gourd with 50%, 55% and 60% sugar solution contained less than 10 cfu/gm. After 2nd months it was found that blanched type candy with 50%, 55% and 60% sugar solution contained 20 and/or < 20 cfu/g. Whereas, unblanched type candy with 55% solution contain 25 and 50% and 60% sugar solution contained less than 20cfu\gm. The total fungal counts of the sample were shown in table 3. It was observed that at the early month the total fungal counts on candy with 50%, 55% and 60% sugar solution contained no yeast and mold. Moreover, after 4 months it was also found that the total fungal counts on candy with 50%, 55% and 60% sugar solution contained nil for blanched type of candy. However, the total fungal counts 50 and 100 for 55% and 60% sugar solution for un-blanched type candy. The total coliform counts of the samples are shown in table 3. During the whole preservation period the total coliform counts in all type of bottle gourd candy were negative. This was true for both blanched and un-blanched candy.

Microbiological Parameter	Type of Sugar Solution	Microbial load (cfu/gm)							
		After 1 Month	After 2 Months	After 3 Months	After 4 Months	After 1 Month	After 2 Months	After 3 Months	After 4 Months
		Candy Prepared with blanched Bottle gourd				Candy Prepared with unblanched Bottle gourd			
Standard Plate Count	50%	< 10	< 10	20	50	20	20	25	30
	55%	< 10	< 10	< 20	< 30	< 10	25	< 20	< 30
	60%	< 10	20	< 20	< 20	< 10	< 20	< 20	< 50
Total Coliform	50%	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	55%	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	60%	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Yeast and Mold Count	50%	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	55%	Absent	Absent	Absent	Absent	Absent	Absent	Absent	50
	60%	Absent	Absent	Absent	Absent	Absent	Absent	Absent	100

Table 3: *Microbiological analysis of bottle gourd candy prepared from blanched and un-blanched candy.*

Discussion

To improve the final product quality soaking of food in osmotic medium before air drying is an effective practice as the osmotic solution help decrease acidity of fruit or vegetables which subsequently prevents the oxidative browning [25]. Moreover, the same osmotic treatment before freezing help improve the texture, flavor, and color after thawing [26] and reduce the drip loss during freeze [27]. Candy is a sort of sugary product which defines a range of sweet commodities and the meanings vary from country to country. Candy prepared from raw bottle gourd were stored in normal room temperature. It was found that even after one month of storage, quality of the processed products was different to that of freshly processed products.

Moisture is one of the important determinants of durability of food against microbial spoilage. Increased water content (increased water activity) of food make suitable for microorganism to grow and spoiled the food. In addition, the texture, taste, freshness and even the consumer acceptance are dependent on water content of food [28-30]. The moisture content of bottle gourd candy was analyzed at different time points, like after ½, 1, 2, 3 and 4 hours, during the osmotic dehydration experiment. The effect of desiccation time on loss of moisture specifies that as the reduction of moisture content increases as the time elapsed. Proteins are of importance in human food with respect of two aspects namely, nutrition and desired textural quality of food. Proteins are the source of dietary amino acid and are used for growth and maintenance of living systems. Protein imbalance in food leads to malnutrition [31]. Since through osmotic process water molecules passage out of food materials into the outer solution. Along with this water, water soluble proteins are also move out of the food and proteins are lost.

The mean solid gain was found to be higher as the concentration of sugar solution was increased. Moreover, the increased dehydration time tend to increase the amount of solid gain. In addition, the kinetics of water loss at different process conditions was obtained as the dehydration time increases, the amount of water losses also increases.

Generally, fruits and vegetables are poor sources of fats and lipids and bottle gourd is not different, contain tiny fraction of fat with over 95% of water. Gradual decreases of fat of all types of bottle gourd candies was observed during the 4 months of observation period. This decrease in fat content is specifically due to oxidation of fat and a rancid flavor was develop. Ash is the incineration products of organic substances and ash is connected to minerals like, Mg, Na, Ca and phosphorus [32,33]. The lower ash content was followed with the higher concentration of sugar solution used and the vice-versa. As, salt drips out of food along with water throughout osmotic process and ash content is eventually reduced. The higher sugar concentration was observed on candy made with higher sugar concentration and the reason is quite simple as higher sugar leave higher amount of sugar in the final products.

Though, color does not belong any nutritional value, it regarded as one of the vital elements of quality of final products. The ocular appraisal of food comes first, since color is the first attribute that attract the consumer. Moreover, freshness and maturity are specified by color [34]. Color can encourage emotive response, affect smoothness, mirrors status, and color can undoubtedly affect a customer's general sensitivity of a product [35]. According to the color score provided by the panelist, candy prepared with 55% sugar solution is superior than other. Texture is a quality attribute of food products and the level of firmness, tenderness, coarseness and softness are included under this attribute. Ripe fruits are soft or mushy in nature compared to unripe one [36]. Apandi (1994) reported that, enzyme activity help dissolute pectic material of fruits and vegetables and render the changes in texture [37]. Flavors enhancer are usually added to improve the flavor, which attract the consumer. Moreover, additives could be used to improve the quality and shelf life of final product. The osmoactive substance may have a profound effect on the sensory qualities of the finished product.

From the four months observation of microbial activities, microbial load was increased in month to month duration. The unblanched samples were with higher microbial load than blanched sample. Our study also shows that there is no coliform after 4 month of candy preparation. Yeast and mold were only found after 4 months of preparation, however, only found in candy prepared from unblanched bottle gourd.

Conclusion

In conclusion it can be avowed that the osmotic dehydration technique has a significant positive effect on the quality of bottle gourd candy. The dehydration of product yield moisture content from 4.31% to 8.58%, and the solid gain range from 2.06 to 9.29%. This implied that a total sum of moisture can be removed without placing ample energy to the process. At the same time, the sugar gained (solid gain) by the product acts as a good preservative which may help to the delay of product spoilage. The sensory assessment signposted that most of the panelist liked the product. In terms of microbial load, blanched type candy was found to be superior than un-blanched type. Overall 50% sugar solution yield better candy in terms sensory quality. This study will help the confectionary manufacturer to select the suitable level of sugar solution to make bottle gourd candy with superior quality and extended period of shelf life.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Bibliography

1. BBS. "Yearbook of Agricultural Statistics, Bangladesh, Bangladesh Bureau of Statistics". In: Division S, edition. Dhaka. Bangladesh: Ministry of Planning, Government of the People's Republic of Bangladesh (2014).

2. Ahmad I., *et al.* "Nutritional and medicinal potential of *Lagenaria siceraria*". *International Journal of Vegetable Science* 17.2 (2011): 157-170.

3. Sivaraj N and Pandravada S. "Morphological diversity for fruit characters in bottle gourd germplasm from tribal pockets of Telangana region of Andhra Pradesh, India". *Asian Agri-History* 9.4 (2005): 305-310.

4. Gopalan C., *et al*. "Nutritive value of Indian Foods". National Institute of Nutrition (2004).

5. Jabbar S., *et al*. "Quality of carrot juice as influenced by blanching and sonication treatments". *LWT-Food Science and Technology* 55.1 (2014): 16-21.

6. Bahçeci KS., *et al*. "Study of lipoxygenase and peroxidase as indicator enzymes in green beans: change of enzyme activity, ascorbic acid and chlorophylls during frozen storage". *Journal of Food Engineering* 66.2 (2005):187-192.

7. AOAC. Official Methods of Analysis: Official Method for Moisture, Method No. 925.10. Washington DC: Association of Official Analytical Chemists (1995).

8. AOAC. Official Methods of Analysis: Official Method for Ash. Method No. 936.03. Washington DC.: Association of Official Analytical Chemists (2000).

9. AOAC. Official Methods of Analysis: Official Method for Protein. Method No. 920.87. Washington DC.: Association of Official Analytical Chemists (1995).

10. AOAC. Official Methods of Analysis: Official Method for Fat Extraction. Method No. 920.85. Washington DC: Association of Official Analytical Chemists (1995).

11. AOAC. Official Methods of Analysis: Official Method for Crude Fibre. Method No. 920.85. Washington DC: Association of Official Analytical Chemists (1995).

12. AOAC. Official Methods of Analysis. Washington DC.: Association Official Analytical Chemists (1980).

13. Rastogi N., *et al*. "Developments in osmotic dehydration". In: Emerging technologies for food processing. Elsevier (2005): 221-249.

14. Nieto AB., *et al*. "Osmotic dehydration of apple: Influence of sugar and water activity on tissue structure, rheological properties and water mobility". *Journal of Food Engineering* 119.1 (2013):104-114.

15. Edeoga H., *et al*. "Minerals and nutritive value of some Nigerian medicinal plants". *Journal of Medicinal and Aromatic Plant Science* 25 (2003): 1010-1015.

16. Badau M., *et al*. "Fungi Associated with Various Fresh Meats Sold in Maiduguri Market, Nigeria". *Journal of Pure and Applied Science* 4 (2001): 255-262.

17. Badau M., *et al*. "Bacteriological quality of fresh meat sold in Maiduguri Market, Nigeria". *Journal of Aridland Agriculture* 9 (1999): 133-141.

18. Mosupye FM and Von HOLY A. "Microbiological quality and safety of ready-to-eat street-vended foods in Johannesburg, South Africa". *Journal of Food Protection* 62.11 (1999): 1278-1284.

19. Mudgil S., *et al*. "Microbiological analysis of street vended fresh squeezed carrot and kinnow-mandarin juices in Patiala City, India". *Internet Journal of Food Safety* 3 (2004): 1-3.

20. Harrigan WF and McCance ME. "Laboratory methods in food and dairy microbiology". Academic Press Inc. (London) Ltd (1976).

21. Speck ML. "Compendium of Methods for the Microbiological Examination of Foods". Washington DC: American Public Health Association (1976).

22. Halvorson H and Ziegler N. "Application of statistics to problems in bacteriology: I. A means of determining bacterial population by the dilution method". *Journal of Bacteriology* 25.2 (1933): 101.

23. Larmond E. "Laboratory methods for sensory evaluation of food". Research Branch, Canada Dept. of Agriculture (1977).

24. O'Mahony M. "Sensory evaluation of food: statistical methods and procedures". Routledge (2017).

25. Ponting J. "Osmotic dehydration of fruits: Recent modifications and applications". Process Biochemistry (1973).

26. Bhaktaraj S., *et al*. "Effect of Sucrose Content (0brix) and Different Flavors on Physical, Mechanical and Sensorial Properties of Ginger Candy" (2019).

27. Lazarides HN and Mavroudis NE. "Freeze/thaw effects on mass transfer rates during osmotic dehydration". *Journal of Food Science* 60.4 (1995): 826-828.

28. Ansari S., *et al*. "Effect of moisture content on textural attributes of dried figs". *International Agrophysics* 28.4 (2014): 403-412.

29. Silva BG., *et al*. "Effects of Different Drying Conditions on Key Quality Parameters of Pink Peppercorns (Schinus terebinthifolius Raddi)". *Journal of Food Quality* (2017).

30. Gowen A. "Water and food quality". *Contemporary Materials* 1.3 (2012): 31-37.

31. Sivasankar B. "Food Quality". Food Processing and Preservation Prentice-Hall of India Private Limited, New Delhi (2002): 345.

32. Fazli F and Fazli N. "Evaluation and determination of minerals content in fruits". *International Journal of Plant, Animal and Environmental Sciences* 4.2 (2014): 160-166.

33. Vermani A., *et al*. "Physico-chemical analysis of ash of some medicinal plants growing in Uttarakhand, India". *Nature and Science* 8.6 (2010): 88-91.

34. Smolander M. "Freshness indicators for food packaging. Smart packaging technologies for fast moving consumer goods (2008): 111-127.

35. Sable P and Akcay O. "Response to color: literature review with cross-cultural marketing perspective". *International Bulletin of Business Administration* 11 (2011): 34-41.

36. Baedowi. "Knowledge of Agricultural Produce". Directorate of Vocational High Schools, Department of Education and Culture, Kakarta, Indonesia (1980).

37. Apandi M. "Technology of fruit and vegetables". Terate, Bandung (1994).

Volume 15 Issue 9 September 2020